

Carrasco, Bruno; Mukhopadhyay, Hiranya

**Working Paper**

## Reserve Bank of India's Policy Dilemmas: Reconciling Policy Goals in Times of Turbulence

ADB Economics Working Paper Series, No. 393

**Provided in Cooperation with:**

Asian Development Bank (ADB), Manila

*Suggested Citation:* Carrasco, Bruno; Mukhopadhyay, Hiranya (2014) : Reserve Bank of India's Policy Dilemmas: Reconciling Policy Goals in Times of Turbulence, ADB Economics Working Paper Series, No. 393, Asian Development Bank (ADB), Manila, <https://hdl.handle.net/11540/4207>

This Version is available at:

<https://hdl.handle.net/10419/128520>

**Standard-Nutzungsbedingungen:**

Die Dokumente auf EconStor dürfen zu eigenen wissenschaftlichen Zwecken und zum Privatgebrauch gespeichert und kopiert werden.

Sie dürfen die Dokumente nicht für öffentliche oder kommerzielle Zwecke vervielfältigen, öffentlich ausstellen, öffentlich zugänglich machen, vertreiben oder anderweitig nutzen.

Sofern die Verfasser die Dokumente unter Open-Content-Lizenzen (insbesondere CC-Lizenzen) zur Verfügung gestellt haben sollten, gelten abweichend von diesen Nutzungsbedingungen die in der dort genannten Lizenz gewährten Nutzungsrechte.

**Terms of use:**

*Documents in EconStor may be saved and copied for your personal and scholarly purposes.*

*You are not to copy documents for public or commercial purposes, to exhibit the documents publicly, to make them publicly available on the internet, or to distribute or otherwise use the documents in public.*

*If the documents have been made available under an Open Content Licence (especially Creative Commons Licences), you may exercise further usage rights as specified in the indicated licence.*



<https://creativecommons.org/licenses/by/3.0/igo/>

# RESERVE BANK OF INDIA'S POLICY DILEMMAS: RECONCILING POLICY GOALS IN TIMES OF TURBULENCE

*Bruno Carrasco and Hiranya Mukhopadhyay*

**NO. 393**

March 2014

**ADB ECONOMICS  
WORKING PAPER SERIES**



ADB Economics Working Paper Series

## Reserve Bank of India's Policy Dilemmas: Reconciling Policy Goals in Times of Turbulence

Bruno Carrasco and Hiranya Mukhopadhyay  
No. 393 | March 2014

Bruno Carrasco is Director and Hiranya Mukhopadhyay is Senior Public Management Economist of South Asia Public Management, Financial Sector and Trade Division, Asian Development Bank.

The authors wish to thank Subir Gokarn, Head of Research, Brookings India and former Deputy Governor of the Reserve Bank of India; and Abhijit Sen Gupta, Senior Economist, ADB India Resident Mission for their insightful comments and useful suggestions. The authors also wish to thank Rosa Mia Arao for her excellent research support. All usual disclaimers apply.

Asian Development Bank  
6 ADB Avenue, Mandaluyong City  
1550 Metro Manila, Philippines  
[www.adb.org](http://www.adb.org)

© 2014 by Asian Development Bank  
March 2014  
ISSN 1655-5252  
Publication Stock No. WPS146349

The views expressed in this paper are those of the author and do not necessarily reflect the views and policies of the Asian Development Bank (ADB) or its Board of Governors or the governments they represent.

ADB does not guarantee the accuracy of the data included in this publication and accepts no responsibility for any consequence of their use.

By making any designation of or reference to a particular territory or geographic area, or by using the term “country” in this document, ADB does not intend to make any judgments as to the legal or other status of any territory or area.

Note: In this publication, “\$” refers to US dollars.

The ADB Economics Working Paper Series is a forum for stimulating discussion and eliciting feedback on ongoing and recently completed research and policy studies undertaken by the Asian Development Bank (ADB) staff, consultants, or resource persons. The series deals with key economic and development problems, particularly those facing the Asia and Pacific region; as well as conceptual, analytical, or methodological issues relating to project/program economic analysis, and statistical data and measurement. The series aims to enhance the knowledge on Asia’s development and policy challenges; strengthen analytical rigor and quality of ADB’s country partnership strategies, and its subregional and country operations; and improve the quality and availability of statistical data and development indicators for monitoring development effectiveness.

The ADB Economics Working Paper Series is a quick-disseminating, informal publication whose titles could subsequently be revised for publication as articles in professional journals or chapters in books. The series is maintained by the Economics and Research Department.

## CONTENTS

ABSTRACT	v
I. INTRODUCTION	1
II. RESERVE BANK OF INDIA'S PERFORMANCE	3
III. TO REACT OR NOT TO REACT: THE LINK BETWEEN FOOD PRICE INFLATION AND CORE INFLATION	8
IV. POLICY EFFECTIVENESS AND THE STATE OF THE CREDIT MARKET	13
V. CRITICAL ASSESSMENT OF RBI POLICIES	19
VI. CONCLUSION	20
APPENDIX	21
REFERENCES	22



## **ABSTRACT**

This paper reviews some of the more critical policy dilemmas facing the Reserve Bank of India (RBI) in its pursuit of inflation stabilization and balanced growth objectives. The challenge in meeting these objectives further increased in the mid-2000s with the advent of large capital flows into the country and with RBI's role in preserving financial stability. The paper argues, drawing on several empirical results including Taylor rule estimation and nonparametric regression, that there is no simple policy solution to apply in different states of the market and reviews policy decisions undertaken by RBI against the backdrop of a disequilibrium framework where credit markets may be demand or supply constrained. Superimposing two capital flow regimes into this framework leads to identification of episodes where a hawkish (anti-inflationary) stance can give way to a dovish(pro-growth) stance.

Keywords: India, monetary policy dilemmas, central bank, RBI policies, price stability, financial stability, Taylor rule, credit market disequilibrium

JEL Classification: E50, E52, E58



## I. INTRODUCTION

Interesting how times have changed. During the period 2001–2006, central bankers were seen as the superheroes of the economy having conquered the almighty elusive inflation. Such was the euphoria that this period was soon after referred to as the Great Moderation in tribute to the success across advanced economy central banks at successfully reining in inflation. The maestro and other central bank rock stars could do no wrong and certainly had their day in the sun. Others were so enthralled by this euphoria that the finance minister of a Group of 7 economy decided to sell off an important share of gold stocks held in reserves. The justification being the genuine belief that the Great Moderation would put an end to the high price of the precious commodity given that inflation would soon be relegated to the history books and hence the precautionary role of gold as a store of value would be significantly reduced. Unfortunately, all that glitters is not gold, and success soon gave way to a reality check with the advent of the global financial crisis. Many central bankers and other apologists of the Great Moderation were soon knocked off their perches and with it some of the fundamental tenets of central banking were brought back in to questioning.

**Central Bank Goals:** Central banks have traditionally sought to pursue a fine balancing act of promoting price stability while maintaining the economy on a sustainable growth path. More recently, with the coming of age of globalization and with it large and fickle cross-country flow of capital, financial stability has been added to the balancing act. As any aspiring juggler will note, it is much harder to balance three balls in the air than two. Moreover, when capital flows begin to increase in magnitude so as to potentially impact the exchange rate and even lead to large increases in net foreign assets in the banking system, the pressure on delivering the goal of price cum economic stability becomes potentially much more challenging. Nowhere has this become more apparent than across central banks in emerging market economies (EMEs).

**Reserve Bank of India (RBI) Goals—how it operates, and policy dilemmas:** As with other central banks, the RBI is responsible for primarily two major goals. In pursuit of its first goal, it is expected to maintain domestic price stability and in so doing and whenever possible accommodate a flexible growth–inflation balance (see Mohan 2011). However, and more recently, in addition to this goal, the RBI had to increasingly ensure financial stability (see Gokarn 2010). The challenge in meeting the first goal is often exacerbated by the fact that in the absence of full autonomy of the central bank, the government often tends to exert pressure on the central bank to pursue pro-growth strategies. With limited fiscal space to pursue demand management policies and/or in the run-up to elections, this pressure can be further increased. The challenge in meeting the second goal, financial stability involves among others, getting the right balance between monetary policy and macro-prudential management.

In undertaking the policies to support these goals, the monetary authorities need to take stock of the state of the domestic economy, including the credit cycle, as well as projections on where the economy is heading.

Much to the concern of policymakers, this has led to potentially large trade-offs among the various policies that are often used to meet these challenges. In so far as price stability is concerned, RBI's policies are aimed at ensuring that the supply of broad money does not grow at a rate that is inconsistent with the level of economic activity of the economy, given the prevailing inflation, inflation expectations and growth outlook of the economy. Externally—and in particular in small open economies—the financial authorities seek to maintain the stability of the external value of the rupee,

to the extent that it can impact inflation (and inflation expectations), financial stability—through the effects of asset price build-up—and economic growth.

However, to add to the challenge, central bankers across EMEs tend to have fewer policy instruments at their disposal and their use is often more limited and at times more blunt than their more advanced counterparts. In the case of RBI, a host of instruments are available which can be listed under two broad categories. In the short term, the central bank intervenes through the repo rate—the central bank policy instrument—to affect the cost of borrowing by banks. The repo rate and the reverse repo rate effectively provide the bandwidth along which the overnight call-money rate is set. In the short to medium run, the RBI influences the net demand for the rupee by changing the spot interest rates, and by buying and selling dollars in the foreign exchange market. The spot interest rate is either affected directly, by changing key rates like the bank and the repo rates, or indirectly, by way of changes in the cash reserve ratio (CRR). At the same time, the central bank controls the longer run trend in cross-border capital movement by carefully managing the degree of convertibility, if needed, of the Indian rupee (Rs), on the capital account. Additionally, as mentioned earlier—assuming that inflation is under control—the RBI is often expected to provide stimulus to the real sector of the Indian economy, essentially by way of reducing the cost of borrowing. Often, such a stimulus comes in the form of a reduction in repo and bank rates. At other times, these measures are supplemented by a reduction of the CRR leading to a fractional downward shift of the yield curve.

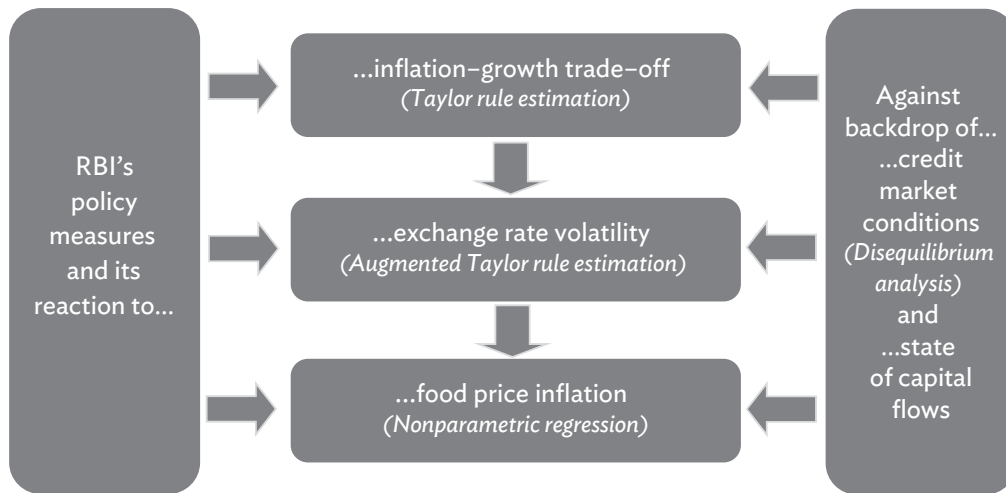
At the very outset, it should be noted that the objectives of the RBI are not necessarily compatible with each other.<sup>1</sup> For example, suppose that raising interest rates is an appropriate measure in the face of a sharp depreciation of the rupee, or for moderating inflation expectations. Then, it is evident that during such times the central bank will not be able to respond to the demand for expansionary monetary policy that is, at least in principle, consistent with accelerated economic growth. In other words, at any given point of time, the RBI is forced to make a choice, assigning greater priority or weight to one goal over another. To address this concern, RBI recently proposed to adopt inflation as the nominal anchor for monetary policy framework (RBI 2014).

**Goal of this paper:** Given these policy dilemmas, this paper will attempt to shed further light on some of the major on-going policy debates that RBI has faced in recent years. We take a three-pronged approach to provide a critical assessment for RBI's recent policy measures (see Figure 1). First, despite the inflation growth balance—or perhaps at times trade-off—what has been the evidence as far as the weight RBI attaches to these two goals? Furthermore, how has the advent of large capital flows influenced these two goals recognizing the impact of capital flows on exchange rates and inflation and growth? In particular, can we discern any further evidence on how RBI has managed the financial trinity problem where with increasingly mobile capital flows, the policymaker cannot simultaneously target price and exchange rate stability while supporting domestic growth objectives? Second, a more practical debate has evolved around the major driver of inflation in India, namely, commodity and in particular food prices. Should RBI be reacting to food price inflation or should it not, recognizing the supply side or structural constraints that deem to be driving high food prices? Finally, there has been an increasing view that central banks may need different, even multiple, instruments in different situations to meet policy objectives (see Gokarn 2010). In this paper we take a slightly different variant to this tenet and ask whether policy instruments may be more or less effective in different situations with a specific focus on the state of the credit market in India?

---

<sup>1</sup> The perception in the market echoes this sentiment as supported by Jahangir Aziz, Chief Economist in Asia for JPMorgan where he refers to “Monetary policy has juggled too many things at the same time and what it has ended up doing is trading off one objective against other” (*Financial Times* 2014).

Figure 1: Assessment of Reserve Bank of India's Recent Policy Measures



RBI = Reserve Bank of India.

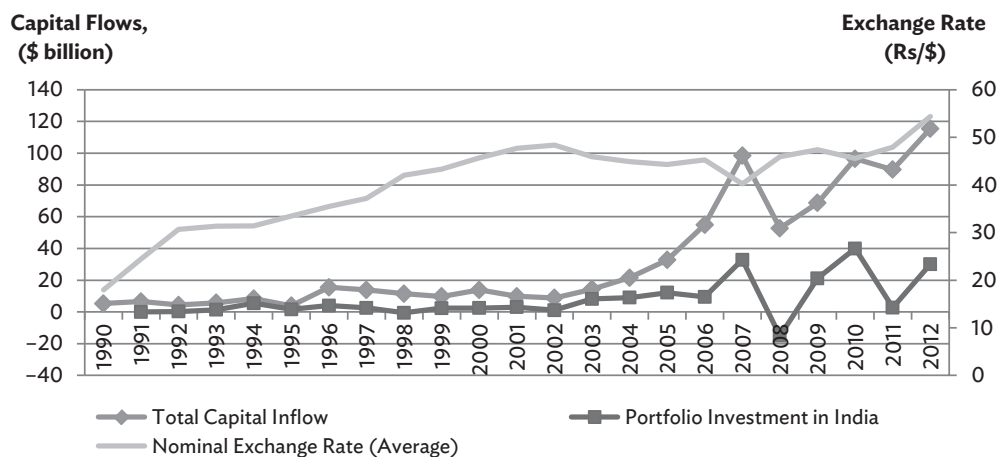
Source: Authors' illustration.

This paper is structured along the following lines. Section II reviews the performance of RBI in terms of growth–inflation parameters to assess how well it has carried its responsibilities. Section III deepens the analysis in the face of what is arguably a key policy dilemma, namely, whether or not RBI should react to increasing food prices observed in the economy. Section IV provides further introspection on policy decisions based on the state of the credit market to attempt to discern episodes of greater policy effectiveness. Section V seeks to synthesize the findings to critically assess decisions undertaken. Finally, Section VI concludes.

## II. RESERVE BANK OF INDIA'S PERFORMANCE

**May you live in interesting times.** From the mid-1990s, with the liberalization of the current account together with the increasing integration into the world economy, the flow of foreign investment into India began to increase. In the period 2004–2007, net capital inflow increased nearly four-fold from \$28 billion to nearly \$107 billion. Increasing capital inflow brought greater volatility driven by portfolio investment. This was particularly pronounced during 2006–2012 (see Figure 2). However, increasing capital flows also resulted in a build-up of net foreign assets. Unless sterilized, the proceeds of such foreign assets can lead to a rapid increase in credit growth in the economy potentially fuelling economic growth and inflation (see Sen Gupta and Sengupta 2014 for a review of sterilization episodes in India).

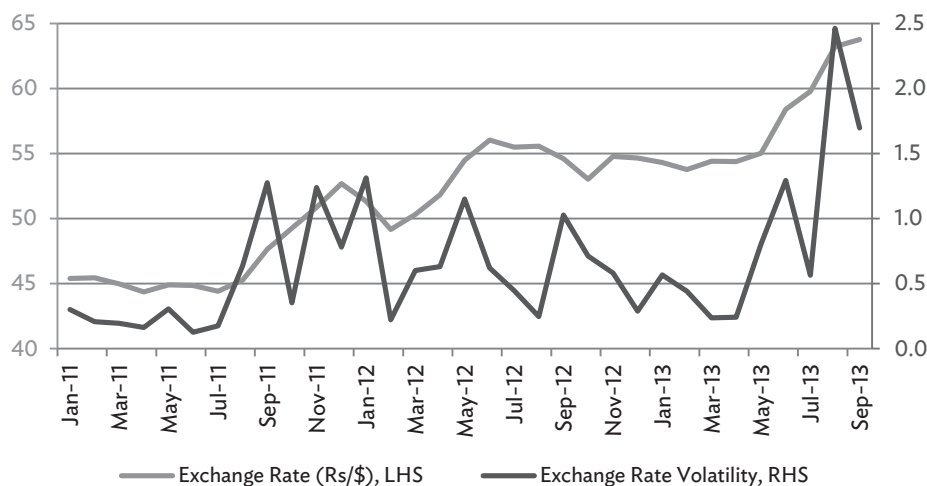
Figure 2: India's Capital Flows



Source: CEIC Data Ltd. (accessed 13 Nov 2013).

Throughout this period, the rupee remained a partly convertible currency in international foreign exchange markets. With increasing capital flows, the rupee became much more prone to changes in its external value with fluctuations in the exchange rate reflecting buying and selling pressures as capital flowed in and out of the economy, as well as other speculative pressures. Focusing on the more recent past, exchange rate volatility has remained significant from mid-2011 to date (see Figure 3). This increasing volatility of the exchange rate came to represent a new norm for RBI. Exchange rate stability was no longer seen to be an afterthought by the central bank and exchange rate volatility was, in the least, complicating efforts to ensure the dual mandate of containing inflation while supporting stable gross domestic product (GDP) growth.

Figure 3: Exchange Rate Volatility



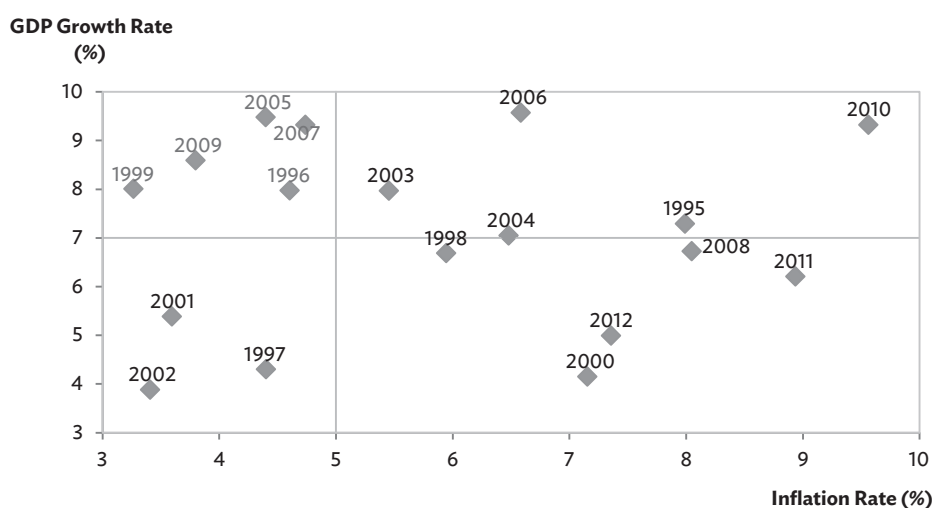
Note: Monthly exchange rate volatility is computed as the standard deviation of the daily nominal exchange rate for the month.

Source: Staff estimates based on data from RBI.

**Against this backdrop, what has the performance been?** Taking the post-1991 crisis as the starting point, inflation—as measured by the wholesale price index (WPI) has averaged approximately 5.9% per annum over the period 1995–2012. During this period, WPI has ranged from 3.3% per annum at its lowest in 1999, to 9.6% at its peak in 2010. During this same period, annual GDP growth has averaged 7.0% ranging from a minimum of 3.9% in 2002 to 9.6% in 2006.

With an implicit WPI inflation target of 5% and a sense that post-2000 GDP growth rate of below 7% is likely to lead to pressures from the government, the RBI has had its work cut out given the need to steward the economy along these two broad parameters. If we assess performance based on these two parameters, RBI has a strike ratio of 28% during the period 1995–2012 (see Figure 4).<sup>2</sup>

**Figure 4: Scatter Plot of GDP Growth on Inflation in India, 1995–2012**



GDP = gross domestic product.

Source: Staff estimates based on data from Ministry of Statistics and Programme Implementation (MOSPI).

**What does the Taylor Rule Reveal?** To better understand what drives policy rates and how RBI has fared in addressing the inflation and output stabilization trade off, the following section analyzes a Taylor rule estimate for India.

The original Taylor specification is as follows:

$$i_t = r^* + \pi_t + \beta(\pi_t - \pi_t^*) + \gamma z_t \quad (1)$$

where  $i_t$  is the short term interest rate,  $r^*$  is the equilibrium real interest rate,  $\pi_t$  is the inflation rate, expressed as annualized percentage changes in the price level,  $\pi_t^*$  is the targeted inflation rate, and  $z_t$  is the output gap expressed as the annualized percentage deviation of real output from trend (Hodrick–Prescott filter method). In the above equation the parameters  $\pi_t^*$ ,  $r^*$ ,  $\beta$  and  $\gamma$  are treated as constants. Thus, given the values of  $\pi - \pi^*$  and  $z$  for any period the Taylor rule suggests the target value of the short term nominal interest rate,  $i_t$ .

<sup>2</sup> If the inflation cut-off point increased to 7%, then the strike ratio is 44%.

After some adjustments and introducing interest rate smoothing, (most central banks avoid drastic adjustments in the interest rate), we can get a revised functional form with backward looking behavior, i.e., interest rate setting based on observed and not expected inflation and output growth:<sup>3</sup>

$$i_t = \alpha(1 - \rho) + (1 + \beta)(1 - \rho)\pi_t + \gamma(1 - \rho)z_t + \rho i_{t-1} + v_t \quad (2)$$

where  $\rho$  captures the smoothing parameter and lies between 0 and 1. We can derive all the parameters of equation (1) from the estimated parameters of equation (2). Equation (2) is often augmented by the change in the nominal exchange rate but this variable didn't turn out to be significant (see Table 1). For more on this please see below. Two different models have been estimated using headline inflation (WPI) in models 1 and 2, and core inflation (non-food manufacturing) in models 3 and 4. The estimated parameters are in Table 1.

**Table 1: Taylor Rule Estimation for India**

Dependent Variable: Interest Rate Method: Ordinary Least Squares (OLS)				
VARIABLES	Coefficients			
	Model 1	Model 2	Model 3	Model 4
<i>Output Gap</i>	0.0430* (1.707)	0.0527* (1.984)	0.0428 (1.676)	0.0538** (2.034)
<i>Interest Rate<sub>(t-1)</sub></i>	0.709*** (8.710)	0.668*** (7.533)	0.702*** (8.480)	0.652*** (7.312)
<i>Inflation (All Commodities)</i>	0.158** (2.556)	0.133** (2.033)		
<i>Exchange Rate (Change over the quarters)</i>		0.130 (1.125)		0.157 (1.406)
<i>Inflation (Non-Food Manufacturing)</i>			0.161** (2.378)	0.138* (2.012)
<i>Constant</i>	0.875 (1.443)	1.257* (1.813)	1.161** (2.039)	1.545** (2.467)
Observations	51	51	51	51
R-squared	0.697	0.705	0.692	0.705

Notes: Interest rate is proxied by the call money rate while output gap is derived from Manufacturing Index of Industrial Production (IIP). We used two measures of inflation, inflation rate using all commodities and using only non-food manufactured products.

Data spanning 2000Q1–2012Q4.

t-statistics in parentheses \*\*\* p<0.01, \*\* p<0.05, \* p<0.1.

Source: Staff estimates based on data from CEIC Data Ltd. and RBI.

All important coefficients of equation (2) are significant. We can derive the key parameter of equation (1), namely the inflation coefficient,  $(1 + \beta) = 0.54$  and compare this to the output gap

<sup>3</sup> We represent interest rate smoothing as in Virmani (2004) where the central bank is assumed to gradually adjust actual rate to the desired rate as follows:

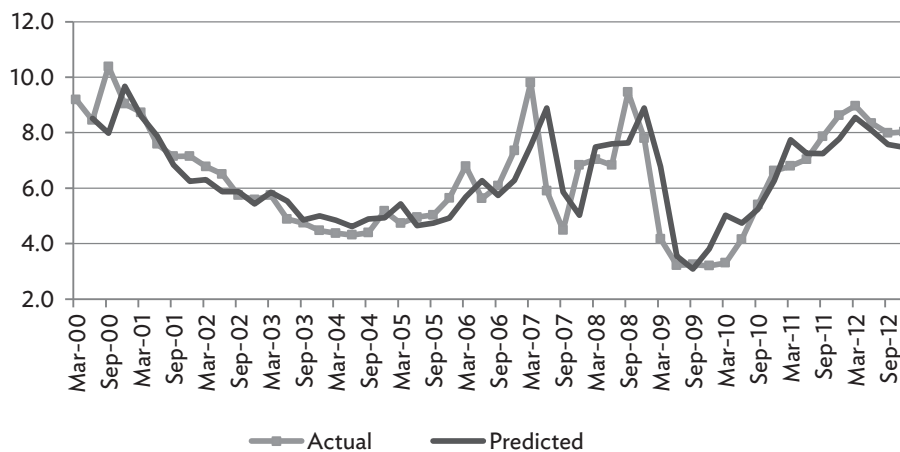
$i_t = (1 - \rho)i_t^* + \rho i_{t-1} + v_t$  where  $0 \leq \rho \leq 1$  captures the observed smoothing in the value of the instrument of the central bank.

coefficient,  $\gamma = 0.15$ .<sup>4</sup> The main message that we derive from this empirical exercise is that despite much criticism that RBI is too easily swayed by growth considerations, inflation stability remains the prime goal of RBI as per the reaction function estimates. Indeed, the inflation coefficient in Table 1 tends to be around 3 times the output gap coefficient which points to the fact that RBI is much more likely to react to inflation pressures than output stabilization considerations. Moreover, the resulting inflation coefficient which is less than one (and greater than 0) essentially implies that the central bank adjusts interest rate proportionally less than inflation and thereby ruling out constancy of the real interest rate. Others have reported the same result (see Virmani 2004).<sup>5</sup>

Another important result derived from these estimates is that the exchange rate variable is not significant. This can be interpreted to mean that RBI does not directly react to changes in the value of the rupee. If one considers the financial trinity, the authorities recognize that with an increasing flow of capital, it is not possible to actively target the exchange rate while attempting to contain inflation while pursuing domestic growth stabilization objectives. This however, does not rule out that RBI can react indirectly to the exchange rate to the extent that it can affect inflation or output (see Carrasco, Gokam, and Mukhopadhyay 2014). The cumulative sum of recursive residuals (CUSUM) test confirms the stability of the parameter estimates (see Appendix as applied to models 1 and 3).

Finally, how does the actual short-term interest rate as established by RBI compare with that predicted by the Taylor rule? According to Figure 5, RBI has been doing a fine job. For many of the RBI detractors that have often criticized policy rates as being too high or too low, this criticism does not appear to be valid based on a comparison with the predicted Taylor rule interest rate.

**Figure 5: Actual and Predicted Interest Rate**



Source: Staff estimates based on data from CEIC Data Ltd. and RBI.

<sup>4</sup> Singh (2010) finds a higher coefficient for output gap than inflation gap during the period 1950–1951 to 1987–1988. However, he notes a shift in policy response in India during the period 1988–1989 to 2008–2009 with monetary policy being more responsive to inflation gap than the output gap.

<sup>5</sup> Virmani (2004) also reported a negative  $\beta$ , which is a sign that the central bank allows for persistence in inflation, accommodating changes in inflation and does not let the real rate rise too much in response to decrease in expected inflation.

### III. TO REACT OR NOT TO REACT: THE LINK BETWEEN FOOD PRICE INFLATION AND CORE INFLATION

In addition to the new norm brought about by increasing capital flows, there has been a key dilemma at the heart of inflation that has polarized the recent debate on policy rates in India. This has to do with food inflation and its persistence in driving overall inflation. The key question is whether or not the central bank should react to increasing pressure of food inflation in attempting to preserve the various policy goals namely price and economic stability. Many experts felt that RBI should not have raised the policy rate in the past because inflation was primarily driven by food prices that largely reflected non-monetary factors such as structural bottlenecks in agriculture. Therefore, reacting by a higher policy rate could have delayed growth recovery in the economy. However, RBI argued that high food price inflation if persistent, would have a second round impact on the core inflation, and a hike in the policy rate was needed, even at the cost of some output loss, to maintain inflation expectations well anchored (Subbarao 2013).

If we consider the past 3 years, we can break this period into two sub-periods characterized by two clear yet very different policy dilemmas (see Figure 6). During the sub-period between January 2010 and July 2011 with manufacturing and overall growth rates declining, there was enormous pressure on RBI to reduce the policy rates. However, this period coincided with rather persistent and relatively high inflation and in response, RBI actually raised the repo rate to stem inflation expectations. This inflation was largely driven by rising food prices in the initial stage followed by increases in non-food manufacturing prices (see Figure 7). In India, food represents a large fraction of the expenditure basket<sup>6</sup> and food inflation can easily have second round effects as it can spill over into wage inflation, and therefore into core inflation. RBI considers that this transmission is rather persistent and more recently abated through such institutional factors as the Mahatma Gandhi National Rural Employment Guarantee Act (MGNREGA) schemes where wages in the rural areas are formally indexed to inflation. Besides, when food is such a dominant share of the expenditure basket, sustained food inflation is bound to ignite inflationary expectations (Carrasco and Mukhopadhyay 2012).<sup>7</sup>

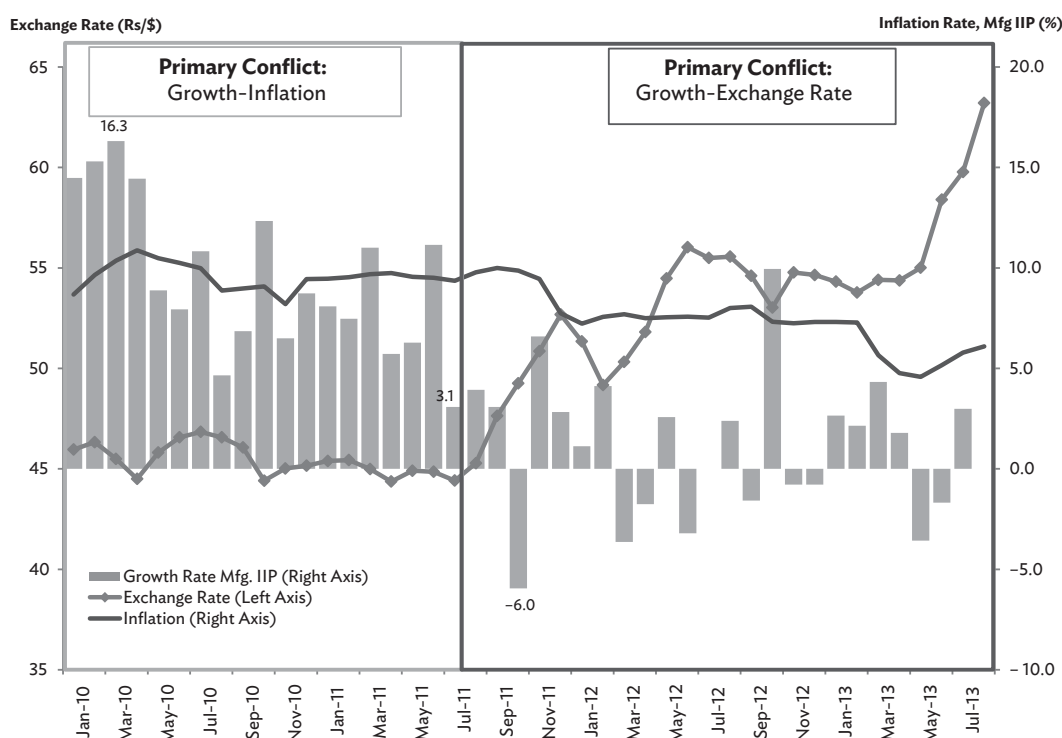
Thus, the link between food inflation and core inflation is at the crux of the policy dilemma that has shaped RBI's anti-inflation stance in recent times. In what follows, we will test empirically the hypothesis that food price inflation indeed influences core inflation in the Indian context.

However, before we close this section by reviewing the second sub-period covering August 2011 to August 2013. Here the policy dilemma was a very different one. Indeed while GDP growth and in particular manufacturing growth continued to decline, it also led to a decline in inflation. The growth and inflation trade-off was no longer an issue as a decline in policy rates would support efforts to strengthen growth with inflationary pressures largely contained. However, with a weakening exchange rate, there was a concern that imported inflation could once again revise inflation expectations upward and lead to a rise in inflation projections over the medium term. In this situation, the dilemma reflects a rise in the policy rate to moderate exchange rate depreciation (uncovered interest rate parity) with downside risks to output growth.

<sup>6</sup> The food share in the overall WPI basket in India is approximately 24.3%.

<sup>7</sup> See Subbarao (2013).

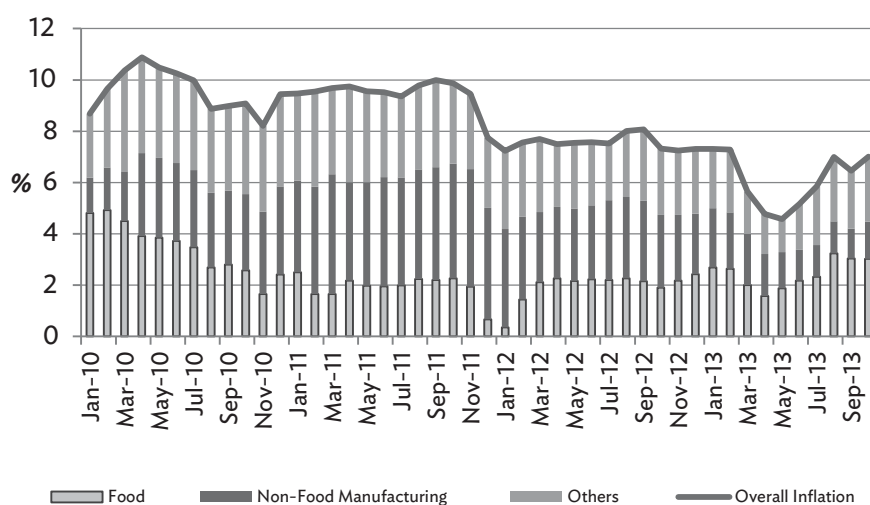
Figure 6: Exchange Rate, Headline Inflation and Manufacturing Growth



IIP = Index of Industrial Production, Mfg = manufacturing.

Source: CEIC Data Ltd.

Figure 7: Components of WPI Inflation in India



WPI = wholesale price index.

Note: Food includes primary food articles and manufactured food products while Others include non-food primary articles and fuel and power.

Source: Staff estimates based on data from MOSPI.

In what follows, we analyze the relationship between food price inflation and core inflation in India with a view toward examining the transmission of food inflation into non-food inflation as well as the persistence of these effects on the core measure of inflation. This topic becomes even more important in light of the persistence and volatility of food inflation in India for the past decade.

Policymakers use the core measure of inflation to get an accurate picture of the current inflation trend shaped by the effects of aggregate demand against capacity utilization. This indeed removes the effects of such factors as temporary and non-core inflation that reflects price movements caused by temporary shocks or more volatile relative price changes. India does not report a measure of core inflation, however, according to Raj and Misra (2011), non-food manufacturing inflation, which the RBI uses as a measure of demand side pressures, satisfies all the three properties for a core measure of inflation. First, a core measure should be more stable or less volatile than headline inflation. Second, over a long period of time, the average rate of core inflation should match the average rate of headline inflation and there should be no system divergence between the two. Lastly, if core inflation represents the underlying trend of inflation, it should then be better able to predict total or headline inflation. The WPI inflation in India is divided into three broad categories: (i) primary articles, (ii) fuel products, and (iii) manufacturing items. For our measure of core inflation, we exclude the first two categories as well as the manufactured food products in the third category to get the non-food manufactured products inflation.

Levin, Natalucci, and Piger (2004) estimated the degree of persistency of inflation by adding the lags included in the autoregressive model of inflation. This approach was also followed in Moriyama (2011) and Benati (2008). Following the same approach, Patra and Roy (2010) reported that the coefficients of lagged inflation contribute nearly 50% to explaining the formation of inflation expectation in India, and this indicates a high degree of inertia or persistence. However, the problem with a univariate autoregressive time series process as suggested by Levin, Natalucci, and Piger (2004) is that it cannot be estimated by ordinary least squares (OLS) method if the time series has persistency since OLS can create downward bias in the estimator  $[\sum \alpha_i]$ . The tendency increases as inflation becomes more persistent. Thus, to overcome this problem, Moriyama (2011) uses a median-unbiased estimator following Andrews and Chen (1994). Another problem is the selection of  $p$  or how many lags to include in the model. Further complicating the model of inflation persistence as pointed out by Darvas and Varga (2013), is that univariate autoregressive models estimated on different samples cannot discriminate among these alternatives: (i) change in the type of underlying shocks, (ii) change on the persistence of the underlying shocks, (iii) change in the monetary policy reaction function, (iv) change in the way the economy responds to shocks or monetary policy actions, or (v) the fact that a linear approximation of an otherwise non-linear underlying structure is poor.

For our purpose of estimating the transmission of food inflation onto core inflation, we model the relationship using a nonparametric regression to avoid imposing a poor linear approximation on the relationship and instead drop all assumptions on the functional form and allowing the data to “speak for itself.”<sup>8</sup> Using annual data from 1981 to 2013, we estimate the following equation,

$$\text{Core inflation}_t = f(\text{Food inflation}_{t-1}) \quad (3)$$

where  $f$  is some unknown and smooth function. In nonparametric regression the shape of  $f$  will be driven by the data.

<sup>8</sup> Gutierrez, Linhart, and Pitblat (2003).

However, not making prior distributional assumptions comes with a price. Nonparametric regression requires large sample sizes since the data creates the model structure and the model estimates. Furthermore, extending nonparametric regression to include several predictors proves to be problematic in practice. The curse of dimensionality in a nonparametric multivariate regression implies that since “multidimensional spaces grow exponentially sparser with the number of dimensions,” “to speak” will require very large samples to estimate nonparametric regression models with many predictors.<sup>9</sup> Moreover, it would be very difficult to visualize a regression surface in more than three dimensions, that is, for more than two predictors. Taking all of these considerations into account, we employ the method of locally weighted scatterplot smoothing (LOWESS) regression where the regression is weighted so that the central point  $(x_i, y_i)$  gets the highest weight and points that are farther away (based on the distance  $|x_j - x_i|$ ) receive less weight. We use the default bandwidth, 0.8, of the statistical package Stata which implies that 80% of the data will be used in smoothing each point. For a detailed description of the LOWESS procedure, see Box 1.

### Box 1: LOWESS Regression

Let  $y_i$  and  $x_i$  be the two variables, and assume that the data are ordered so that  $x_i < x_{i+1}$  for  $i = 1, \dots, N-1$ . For each  $y_i$ , a smoothed value  $y_i^s$  is calculated.

The subset used in calculating  $y_i^s$  is indices  $i_- = \max(1, i-k)$  through  $i_+ = \min(i+k, N)$ , where  $k = b[(N \times \text{bwidth} - 0.5)/2]$ . The weights for each of the observations between  $j = i_-, i_+$  are either 1 (noweight) or the tricube (default),

$$w_j = \{1 - (|x_j - x_i|/\Delta)^3\}^3$$

where  $\Delta = 1.0001 \max(x_{i_+} - x_i, x_i - x_{i_-})$ . The smoothed value  $y_i^s$  is then the (weighted) mean or the (weighted) regression prediction at  $x_i$ .

Source: StataCorp. 2013. Stata 13 Base Reference Manual. College Station, TX: Stata Press.

The results of the nonparametric regression of past food inflation on current core inflation are shown in Figures 8 and 9. From the figures, we can recognize a positive relationship between food and core inflation, that is, higher food inflation levels in the past feeds into higher core inflation in the future. These results provide an empirical justification of why the monetary authorities had to react to food inflation to the extent that it has an impact on future core inflation.

The second issue that we want to explore is whether ‘credibility of policies’ can make the second-round impact stronger. With full credibility, an increase in food price inflation will have little impact on expectations. Market players believe that RBI, notwithstanding the pressure to lower the policy rate to support growth, will stick to a rigid monetary policy stance and inflation will revert back to the target. Thus, the lack of credibility causes a positive inflation expectations bias, which puts upward pressure on inflation through the expectations term in the Phillips Curve (Argov et al. 2007). We therefore create a dummy variable to capture this behavior in the earlier model:<sup>10</sup>

$$D1 = 1 \text{ if growth rate of Manufacturing IIP}_t < \text{growth rate of Manufacturing IIP}_{t-1}$$

<sup>9</sup> Fox (2004).

<sup>10</sup> Market players judge RBI's behavior over weeks, months, and quarters. Thus, for annual data, 1-year lag is found to be adequate.

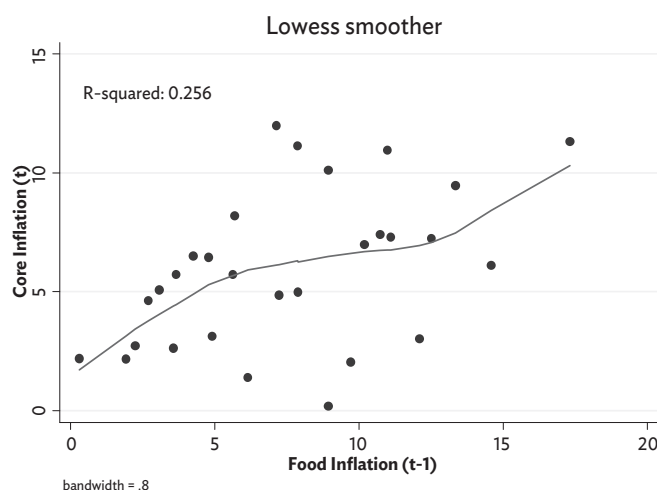
$D1 = 0, otherwise.$

And, define the nonparametric regression specification in the following way:

$$Core\ inflation_t = f((Food\ inflation_{t-1}) * (1 + D1)) \quad (4)$$

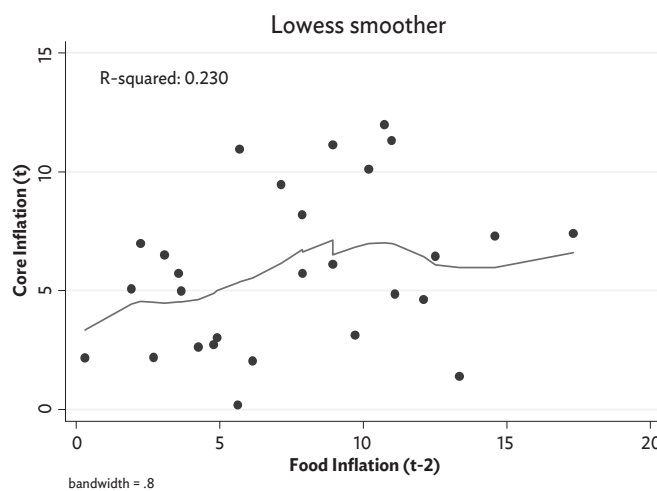
The result of the nonparametric estimation of equation (4) is shown in Figure 10 where we see that the addition of a credibility dummy improved the goodness of fit of the regression. Results show that if manufacturing growth is slow (current manufacturing growth rate is less than last year's growth rate), RBI's rigid monetary policy stance is less than fully credible, and the relationship between food price inflation and future core inflation becomes stronger.

**Figure 8:  $Core\ inflation_t = f(Food\ inflation_{t-1})$**

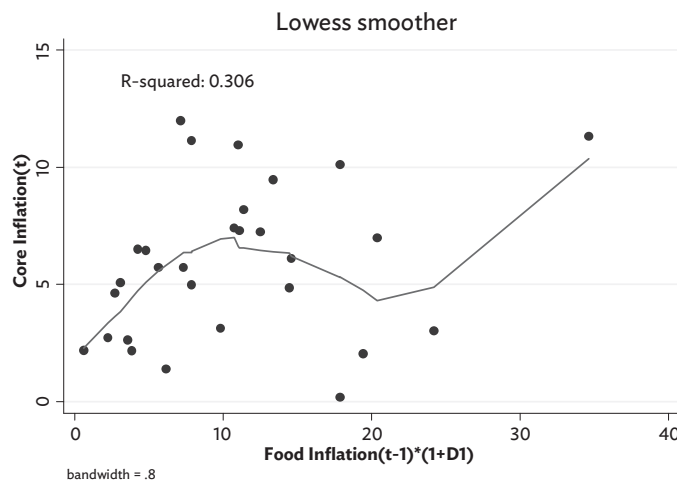


Source: Staff estimates based on data from MOSPI.

**Figure 9:  $Core\ inflation_t = f(Food\ inflation_{t-2})$**



Source: Staff estimates based on data from MOSPI.

**Figure 10:  $\text{Core inflation}_t = f((\text{Food inflation}_{t-1}) * (1 + D1))$** 

Source: Staff estimates based on data from MOSPI.

#### IV. POLICY EFFECTIVENESS AND THE STATE OF THE CREDIT MARKET <sup>11</sup>

There is, however, one question that remains unanswered before we judge the effectiveness of RBI's monetary policy stance. A higher policy rate, as engineered by RBI to dampen inflation expectations may not cool down the market in terms of credit disbursement under certain circumstances. Indeed our results below suggest that if the credit market is in disequilibrium and the market is primarily supply constrained, higher interest rate will lead to a counter intuitive higher credit disbursement as a higher policy rate will not contain the credit demand. Banks will take all necessary steps, including higher deposit rates, to mobilize additional deposits to meet excess credit demand.<sup>12</sup> This will dampen the effectiveness of restrictive monetary policy measures. We will get back to this point at a later stage.

Disequilibrium in the credit market is a well-researched topic in the literature (See for example Stiglitz and Weiss 1981). The disequilibrium framework in the credit market can be reconciled with the fact that markets do not clear instantaneously. Typically, prices are sticky or persistent leading to a situation where price adjustments take time and in between the market is characterized by either a demand or supply constraint. A stricter interpretation could be that the lending rates never equilibrate the demand for and supply of bank credit.

Thus, the model is as follows (see the figure below):

$$C^d = \phi(z)$$

$$C^s = \varphi(W)$$

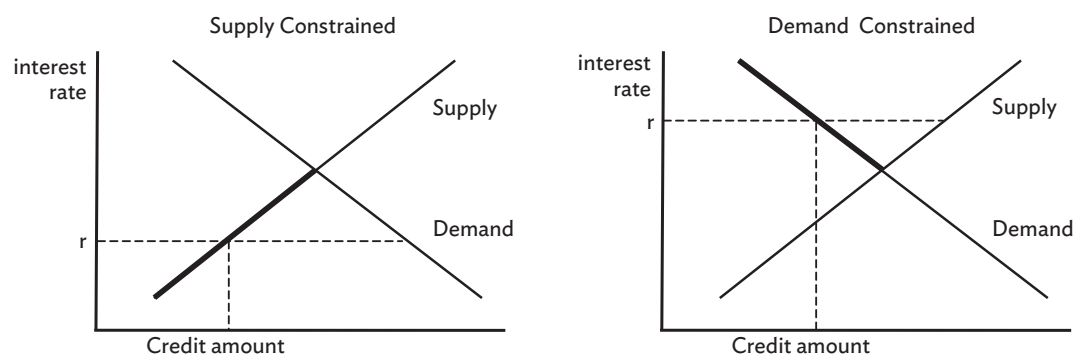
$$C^a = \text{Min}(C^d, C^s)$$

<sup>11</sup> All data used in this section are obtained from RBI's database on the Indian economy. (<http://dbie.rbi.org.in/InfoViewApp/listing/main.do?appKind=InfoView&service=%2FInfoViewApp%2Fcommon%2FappService.do>), and Ministry of Statistics and Program Implementation ([http://www.mospi.nic.in/mospi\\_iip.htm](http://www.mospi.nic.in/mospi_iip.htm)). This is an updated version of the model in the paper of Carrasco and Mukhopadhyay (2011).

<sup>12</sup> Banks behave in a similar fashion when CRR is raised and there is unmet credit demand. Banks also resort to liquidation of government securities in order to fund their credit demand.

where  $C^d$ ,  $C^s$ , and  $C^a$  are demand for non-food bank credit, supply of bank credit and actual disbursement of credit respectively.  $Z$  and  $W$  are different sets of explanatory variables.  $C^d$  and  $C^s$  are in this model the amount of bank credit demanded and supplied, but they are not observed by any external party. Only the amount of bank loan which was actually received, the transaction amount  $C^a$ , can be observed. Thus, in a situation where the credit market is supply constrained, higher interest rate will lead to higher credit disbursement (see Figure 11 and Table 2).

**Figure 11: Disequilibrium Credit Market**



Source: Authors' illustration.

**Table 2: Effectiveness of Policy in a Disequilibrium Framework**

	If Credit Market is Supply Constrained	If Credit Market is Demand Constrained
Hike in Policy Rates	Not effective	Effective
Cut in Policy Rates	Not effective	Effective

Source: Authors' calculations.

We model below non-food bank credit in a disequilibrium framework that allows us to determine whether bank credit is demand determined or supply determined, that is, by the availability of loanable funds with the commercial banks. The empirical exercise requires that the demand and supply sides of the market for bank credit be modeled in the best possible manner, given the constraints involving availability of data. In the context of a credit rationing or the lack of demand for credit, the appropriate dependent variable is arguably the growth rate of credit, as opposed to the absolute value of the same. Indeed, the absolute value of credit increased during the time period under consideration. However, growth in bank credit remained low from one month to the next. Hence, the growth rate of non-food bank credit (*GCREDIT*) has been used as the dependent variable in our model.

It can be argued that the demand for credit depends on two factors: perception of industrial growth—as a proxy for aggregate demand—and cost of borrowing. It is reasonable to assume that past and present growth in the index of industrial production will provide a reasonable measure of expectations about the future rate of industrial growth. Indeed, under the assumption of partial perfect foresight, some average of the past and present rates of growth of the index should be equal to the projected future rate of growth. Hence, a simple average of the present rate of growth of the index, and

5 previous months' growth of the same, has been used as a measure of expectations about the future rate of growth for the (manufacturing) industry. This variable is denoted by *GIIP*. The cost of borrowing, on the other hand, is dependent on the prevailing lending rates which are, in turn, the sum of some base (or risk free) rate and a risk premium. The variation in the risk-free lending rate is extremely limited over months; however, the cost of borrowing can fluctuate due to the risk-premium. In the absence of an accurate proxy for the base rate with reliable data, only the risk-premium is introduced in the model.<sup>13</sup>

The aforementioned risk arises out of the following factor. While the index for industrial production might have an upward trend in general, there might be significant volatility in the context of industrial growth, higher volatility being traditionally associated with higher risk. In other words, the standard deviation in the aforementioned index is a measure of the sector specific risk, and in this case would reflect the risk faced by the manufacturing industries. Hence, the standard deviation of the index for the present month and 5 previous months taken together can be accepted as a reasonable measure of risk. The risk premium charged by banks can be assumed to be some linear function of this risk, and hence it can be further assumed that the measure of risk discussed above can itself be used in lieu of the risk premium.<sup>14</sup> This yields the variable, *RISK*. To better capture the factors affecting the demand for credit, we interact industrial growth with the risk premium and name this variable as *GIIP\*RISK*.

The banks, or lenders, however, not only take into consideration the lending rates, they are also constrained in their ability to supply credit by their deposit base. While this is not a general principle, in many countries such as India, loanable funds are to a large extent sourced from their deposit base. Specifically, the growth of credit supplied by banks is critically dependent on the growth in the volume of deposits which, net of the CRR and the statutory liquidity ratio (SLR) requirements, determines the extent to which the banks can lend. In other words, *GCREDIT* from the supply side is determined in part by the growth in the loanable funds of the banks (*GLOANF*). The specification of *GLOANF* also enables us to capture the post financial crisis changes in CRR and SLR.

The disequilibrium model is estimated using data from January 2010 to July 2013. We estimate the above model by the maximum likelihood technique as developed by Nelson and Maddala (1974) to derive the unconditional probability of  $C^d < C^s$ .

The regression results are summarized in Table 3.

The results in Table 3 show that the demand for credit decreases as the risk premium increases (Model 1). However, this effect is partially diminished with expected higher growth in industrial production. The results also show that the supply of credit is also sensitive to the risk premium—the higher the risk premium, the lower the credit provided by the commercial banks. As expected, growth in loanable funds exerts a positive and significant effect on the supply of credit. But can supply of credit be negatively related to risk-premium? Indeed it can, in the event the banks fear that higher risk-premium will lead to adverse selection such that their credit portfolios will become riskier (Stiglitz and Weiss 1981).<sup>15</sup> Such credit rationing has been observed in other countries as well (Baldensperger and

<sup>13</sup> This may not create a serious omitted variable bias unless we believe that the base rate and the risk-premium are highly correlated.

<sup>14</sup> The risk-premium can also vary across firms depending upon the credit worthiness of the firm.

<sup>15</sup> Stiglitz and Weiss (1981) show why the price mechanism may not clear the market. They came to the conclusion that banks will rather ration credit than increase the interest rate due to adverse selection and moral hazard problems. See also Bhaumik and Mukhopadhyay (1997).

Dermine 1987). Under the present paradigm, when the banks are required to make provisions for all doubtful and non-performing loans and maintain a minimum capital adequacy ratio, it is reasonable for banks to minimize the risk to return ratio of their portfolio.

**Table 3: Switching Regression: Maximum Likelihood Estimates**  
(January 2008–July 2013)

Dependent Variable: Growth in Non-food Bank Credit				
	Model 1		Model 2	
	Demand Function	Supply Function	Demand Function	Supply Function
Constant	18.853 (13.06)	23.325 (7.68)	16.411 (27.65)	17.882 (4.15)
GIIP*RISK	0.115 (4.61)		-0.0408 (-1.12)	
GIIP			0.978 (3.66)	
RISK	-0.359 (-4.65)	-1.045 (-4.65)		-0.790 (-2.18)
GLOANF		0.508 (3.89)		0.750 (3.13)

GIIP = average of the present and 5 previous months' growth rate of the Index of Industrial Production (IIP), RISK = standard deviation of the present and 5 previous months' IIP, GLOANF = growth rate of loanable funds (LOANF), LOANF = aggregate bank deposit adjusted for changes in CRR and SLR.

Note: Figures in parentheses are t-values.

Source: Staff estimates based on data from CEIC Data Ltd. and RBI.

The estimated parameters have subsequently been used to compute the unconditional probability that<sup>16</sup>

$$GCREDIT = \phi(Z)$$

i.e., that the credit market is constrained from the demand side (for any one time period). The estimated probability values for all the months in question are enumerated in Table 4. Since the natural probability of the event that the credit market is demand constrained is 0.5, it can be argued that if the probability for any time period (as in Table 4) is greater than or equal to 0.5, then for that month the credit market was constrained from the demand side. Conversely, if any of the given probabilities is less than 0.5 then for that time period the credit market was constrained from the supply side.

<sup>16</sup> Given the parameter estimates of the demand supply functions, the unconditional probability  $p$  that that observed credit belongs to demand constrained regime in any period is  $p = \phi(m)$  where  $m = (\theta_2 W - \theta_1 Z)/\sigma$

Where  $\theta_1$  and  $\theta_2$  are the parameter estimates of the demand and supply functions respectively, and  $\sigma = (S_1^2 + S_2^2)^{1/2}$ ,  $S_1$  and  $S_2$  are the estimates of the error variances.

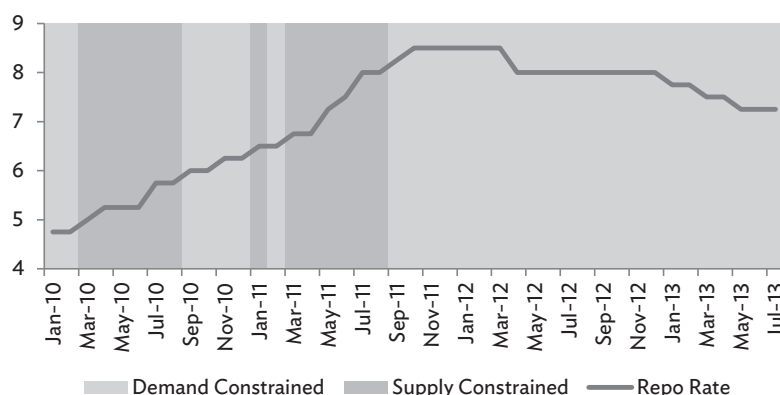
Table 4: Constraints Faced by Credit Market

Months	Constraint	Months	Constraint
Jan-2008	Supply	Jan-2011	Supply
Feb-2008	Supply	Feb-2011	Demand
Mar-2008	Supply	Mar-2011	Supply
Apr-2008	Supply	Apr-2011	Supply
May-2008	Supply	May-2011	Supply
Jun-2008	Supply	Jun-2011	Supply
Jul-2008	Supply	Jul-2011	Supply
Aug-2008	Supply	Aug-2011	Supply
Sep-2008	Demand	Sep-2011	Demand
Oct-2008	Demand	Oct-2011	Demand
Nov-2008	Demand	Nov-2011	Demand
Dec-2008	Demand	Dec-2011	Demand
Jan-2009	Demand	Jan-2012	Demand
Feb-2009	Demand	Feb-2012	Demand
Mar-2009	Demand	Mar-2012	Demand
Apr-2009	Demand	Apr-2012	Demand
May-2009	Demand	May-2012	Demand
Jun-2009	Demand	Jun-2012	Demand
Jul-2009	Demand	Jul-2012	Demand
Aug-2009	Demand	Aug-2012	Demand
Sep-2009	Demand	Sep-2012	Demand
Oct-2009	Demand	Oct-2012	Demand
Nov-2009	Demand	Nov-2012	Demand
Dec-2009	Demand	Dec-2012	Demand
Jan-2010	Demand	Jan-2013	Demand
Feb-2010	Demand	Feb-2013	Demand
Mar-2010	Supply	Mar-2013	Demand
Apr-2010	Supply	Apr-2013	Demand
May-2010	Supply	May-2013	Demand
Jun-2010	Supply	Jun-2013	Demand
Jul-2010	Supply	Jul-2013	Demand
Aug-2010	Supply		
Sep-2010	Demand		
Oct-2010	Demand		
Nov-2010	Demand		
Dec-2010	Demand		

Source: Staff estimates based on data from CEIC Data Ltd. and RBI.

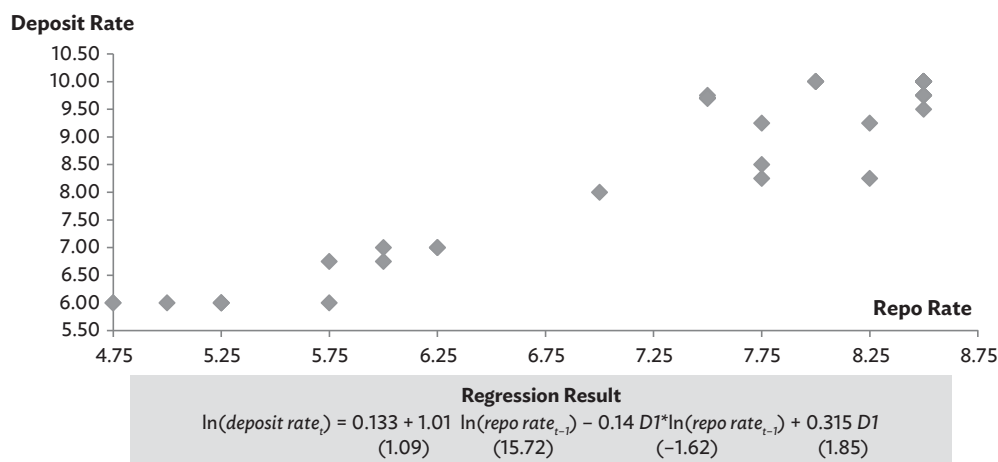
We next map in Figure 12 the credit regimes identified above against the movements in the central bank policy instrument, the repo rate.<sup>17</sup> There are periods when the repo rate rose despite the fact that the credit market was supply-constrained—including March–August 2010, January 2011, and March–August 2011—casting a doubt on the effectiveness of such an intervention on monetary management considerations during those time intervals.

<sup>17</sup> We also tried to match the credit regimes with the systemic liquidity index (SLI) (Mishra, Mohan, and Singh 2012), however, it remained inconclusive.

**Figure 12: Credit Regimes and the Repo Rates**

Source: Staff estimates based on data from RBI.

As we have explained previously, banks could increase the deposit rates to mobilize higher deposit to finance excess demand for credit, primarily because the cost of borrowing from the interbank money market goes up following a hike in the repo rate. Consequently, banks prefer additional deposit mobilization. However, in such episodes, the lending rates will also go up. This effect could also be seen in a demand-constrained regime because banks also borrow from the interbank money market to meet temporary mismatches of funds and to meet statutory liquidity requirements. However, this effect is expected to be much more significant in a supply-constrained regime where banks also need to meet the excess credit demand over and above the RBI mandatory requirements. From the regression results in Figure 13, it can be verified that the elasticity of the deposit rate with respect to the repo rate, with 1-month lag, in a demand constrained regime (equal to 0.87) is much smaller compared to the supply constrained regime (1.01).

**Figure 13: Relationship between Deposit Rate (1-Year Term Deposit) and Repo Rate (Jan-2010—Jul-2013)**

Notes: In the regression result,  $D1$  is a dummy variable equal to one if the observation/month is demand constrained and equal to zero otherwise. Numbers in parentheses are  $t$ -values.

Source: Staff estimates based on data from CEIC Data Ltd. and RBI.

## V. CRITICAL ASSESSMENT OF RBI POLICIES

Synthesizing the findings from the empirical results in the previous sections, we embark on a comprehensive analysis of RBI's monetary policy measures over the period 2010–2013 across inflation, output, and capital flow regimes (Table 5).

**Table 5: A Critical Assessment of RBI's Policy Measures**  
(Jan 2010–July 2013)

A. Strong Capital Flow				
Regime	Period	Demand or Supply Constrained Regime in the Credit Market	RBI's Policy Dilemmas	RBI Response
I. High inflation, low output	Sep 2012–Jan 2013 <sup>a</sup>	Demand	RBI can increase the repo rate to dampen inflation expectations effectively but that would have potentially adverse impact on output growth and exchange rate appreciation.	Repo rate reduced by 25 (basis points) bps in Jan–2013 to 7.75% (50 bps reduction earlier in Apr–2012). Perhaps this was driven by the fact that, despite high inflation and higher priority on inflation expectations, the output growth was negative in Nov–2012 and again in Dec–2012. In other words, loss in output was the primary concern at that point of time (dovish stance).
II. High inflation, high output	Dec 2011–Feb 2012	Demand	RBI can increase the repo rate to dampen inflation expectations effectively without much negative impact on output growth but concerns about stoking exchange rate appreciation could have deepened.	Repo rate unchanged at 8.5% since the 25 bps hike in Oct–11 (see also Figure 12).
	July 2012–Oct 2012 <sup>b</sup>	Demand	Same as above	Repo rate unchanged at 8% since the 50 bps reduction in Apr–12
B. Weak Capital Flow				
I. High inflation, low output	May 2011–Aug 2011	Supply	RBI can increase the repo rate to dampen inflation expectations but it will not be effective in moderating credit demand because of the supply-constrained regime. However, it can improve the capital flows with potentially adverse impact on output growth.	Repo rate increased from 6.75% to 8% in two phases within this period, primarily to counter high inflation (see below). However, inflation continued to hover around 9.5% (hawkish stance).
	Sep 2011–Oct 2011	Demand	RBI, unlike the previous period, can control inflation by raising the repo rate because the credit market is demand constrained. However, that will have an adverse impact on output growth. Furthermore, this measure will also help to boost weak capital inflows.	Repo rate increased twice (in September and again in October) by 25 bps to reach 8.5% from 8% (125 bps increase in the previous period May 2011–Aug 2011). These increases were driven by high inflation during January–November 2011 (average 9.6%), despite subdued manufacturing output growth (hawkish stance).
	Mar 2012–Jun 2012	Demand	Same as above.	Repo rate reduced by 50 bps in Apr–2012 to 8.0% (dovish stance).

Notes: We disaggregated capital flows by using the HP filter method and categorized months where actual flows are above the trend for at least 3 months as strong capital flow and months where actual flows are below the trend for at least 3 months as weak capital flow. Capital flow refers to portfolio investment of Foreign Institutional Investors (FIIs).

High inflation = current inflation > 7%, low inflation otherwise

Low output = current Manufacturing Index of Industrial Production < average of last 3 months of the index, high output otherwise

<sup>a</sup> Excluding the month of October 2012.

<sup>b</sup> Excluding the month of September 2012.

Source: Staff estimates based on data from CEIC Data Ltd. and RBI.

## V. CONCLUSION

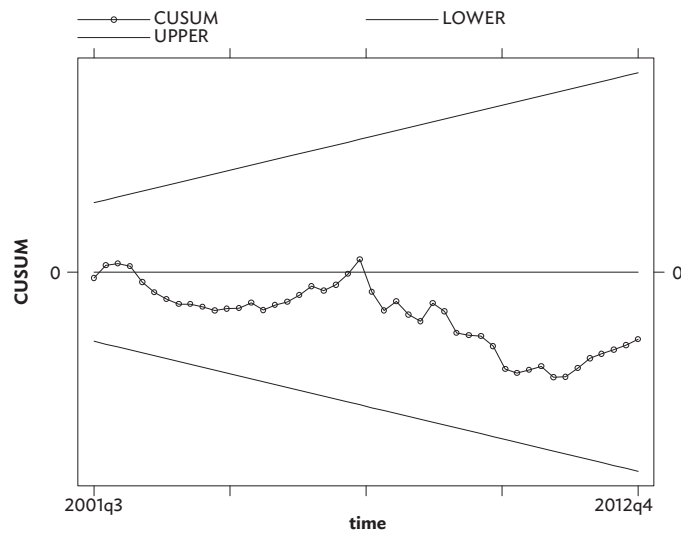
Macroeconomic and monetary management have become extremely complex in a liberalized world due to a potential for conflicting policy objectives. The effectiveness of policy changes critically depends on underlying economic and functional structures of markets, e.g., credit market, foreign exchange market, money market etc. As demonstrated above, there is no simple policy solution to consistently apply in different circumstances with full knowledge about the underlying structure of the economy. As shown, a policy action that may be effective under a particular circumstance, may not be effective when the underlying economic structure changes. For example, in a demand constrained regime with high inflation, weak capital flows and growth below trend, a hike in the policy rate will address the first two concerns at the cost of output growth. However, if the credit market becomes supply-constrained, *ceteris paribus*, a hike in the policy rate is unwarranted.

While central banks tend to be labeled as either strong in fighting inflation (hawkish) or prioritizing growth (dovish) our results tend to suggest that in the case of RBI, the Taylor rule estimate supports evidence of a strong anti-inflationary approach. However, in many circumstances what is a hawkish stance can quickly change into a dovish stance given changes in the underlying objective function. In other words, there is no simple solution to the policy dilemmas and hence we conclude that central banking is not purely a mechanistic application of instruments but rather a prescient combination of applied modelling and judgment by interpreting market forces and adjusting instruments correctly and in a timely manner.

## APPENDIX

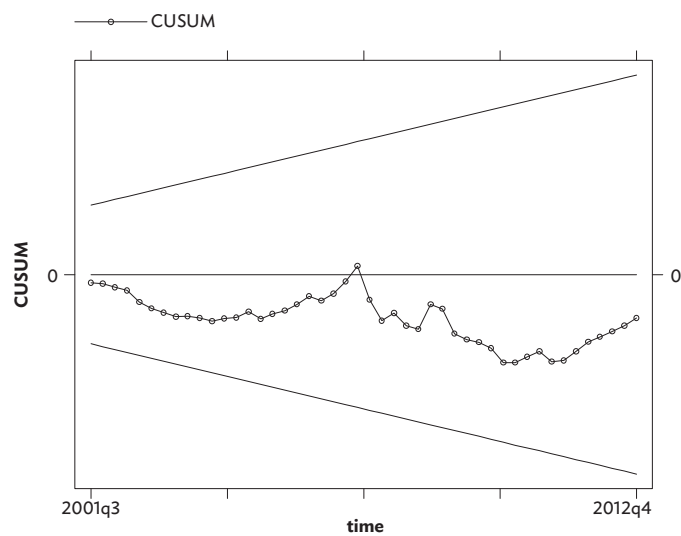
We also tested the stability of the parameter estimates of Table 1 by carrying out the cumulative sum of recursive residuals (CUSUM) test.<sup>1</sup> Results of the CUSUM test for Model 1 and 3 are shown in Figures A and B respectively. The plots of the CUSUM statistic are generally confined within the critical value bounds, suggesting the absence of any instability of the coefficients.

**Figure A: CUSUM test for Model 1**



Source: Staff estimates based on data from CEIC Data Ltd. and RBI.

**Figure B: CUSUM test for Model 3**



Source: Staff estimates based on data from CEIC Data Ltd. and RBI.

<sup>1</sup> CUSUM test uses the cumulative sum of recursive residuals based on the first observations and is updated recursively and plotted against break point. For a detailed description of the CUSUM test see Brown, Durbin, and Evans (1975).

## REFERENCES

- Andrews, D., and H. Chen. 1994. Approximately Median-Unbiased Estimation of Autoregressive Models. *Journal of Business & Economic Statistics* 12(2): 187–204.
- Argov, E., Epstein, N., Karam, P., Laxton, D., and D. Rose. 2007. Endogenous Monetary Policy Credibility in a Small Macro Model of Israel. *IMF Working Paper* WP/07/207. Washington, DC: International Monetary Fund.
- Baldansperger, E., and J. Dermine. 1987. Banking Development in Europe. *Economic Policy*. April.
- Benati, L. 2008. Investigating Inflation Persistence across Monetary Regimes. *Quarterly Journal of Economics* 123(3): 1005–1060.
- Bhaumik, S., and H. Mukhopadhyay. 1997. Was the Industrial Deceleration a Result of Credit Crunch: A Disequilibrium Approach. *Economic and Political Weekly*, 3–9 May.
- Brown, R. L., Durbin, J., and J. M. Evans. 1975. Techniques for Testing the Constancy of Regression Relationships over Time. *Journal of the Royal Statistical Society. Series B (Methodological)* 37(2): 149–192.
- Carrasco, B., Gokarn, S., and H. Mukhopadhyay. Forthcoming. Overview Chapter. In B. Carrasco, S. Gokarn, and H. Mukhopadhyay, eds. *Issues in Capital Account Management*. India: Oxford University Press.
- Carrasco, B., and H. Mukhopadhyay. 2011. India's Monetary Policy Accommodation During the Global Crisis—Was it Effective? In Krishnendu Ghosh Dastidar, Hiranya Mukhopadhyay, and Uday Bhanu Sinha eds. *Dimensions of Economic Theory and Policy Essays for Anjan Mukherji*. India: Oxford University Press.
- . 2012. Food Price Escalation in South Asia. *Economic and Political Weekly*, 17 November, Vol. XLVII, No. 46.
- Darvas, Z., and B. Varga. 2013. Inflation Persistence in Central and Eastern European Countries. *Bruegel Working Paper* 2013/04. Brussels: Bruegel.
- Financial Times*. 2014. India Central Bank Considers Inflation Targeting. 22 January.
- Fox, J. 2004. Nonparametric Regression. <http://socserv.mcmaster.ca/jfox/Nonparametricregression.pdf> (accessed 30 October 2013).
- Gokarn, S. 2010. Monetary Policy Considerations after the Crisis: Practitioners' Perspectives. Plenary Lecture at the conference *Economic Policies for Inclusive Development*, organized by Ministry of Finance, Government of India and National Institute of Public Finance and Policy at New Delhi.
- Gutierrez, R., Linhart, J., and J. Pitblad. 2003. From the Help Desk: Local Polynomial Regression and Stata Plugins. *The Stata Journal* 3(4): 412–419.

- Levin, A., Natalucci, F., and J. Piger. 2004. Explicit Inflation Objectives and Macroeconomic Outcomes. *European Central Bank Working Paper* No. 383. Frankfurt-am-Main: ECB.
- Maddalla, G. S., and F. Nelson. 1974. Maximum Likelihood Methods for Models of Markets in Disequilibrium. *Econometrica* 42(6): 1013–1030.
- Mishra, R. N, G. Jagan Mohan, and S. Singh. 2012. Systemic Liquidity Index for India. *RBI Working Paper Series* 10.2012. Mumbai: RBI.
- Mohan, R. 2011. *Growth with Financial Stability: Central Banking in Emerging Market*. New Delhi: Oxford University Press.
- Moriyama, Kenji. 2011. Inflation Inertia in Egypt and its Policy Implications. *IMF Working Paper* 11/160. Washington, DC: International Monetary Fund.
- Patra, M, and P. Roy. 2010. Inflation Expectations and Monetary Policy in India: An Empirical Explanation. *IMF Working Paper* WP/10/84. Washington, DC: International Monetary Fund.
- Raj, J., and S. Misra 2011. Measures of Core Inflation in India – An Empirical Evaluation. *Reserve Bank of India Department of Economic and Policy Research Working Paper* 16/2011. Mumbai: RBI.
- Reserve Bank of India (RBI). 2014. Report of the Expert Committee to Revise and Strengthen the Monetary Policy Framework (Chairman: Urjit Patel, Deputy Governor). Mumbai.
- Singh, B. 2010. Monetary Policy Behaviour in India: Evidence from Taylor-type Policy Frameworks. *RBI Staff Studies* SS (DEAP): 2/2010. Mumbai: RBI.
- Sen Gupta, A., and R. Sengupta. Forthcoming. Negotiating the Trilemma and Reserve Management in an Era of Volatile Capital Flows. In B. Carrasco, S. Gokarn, and H. Mukhopdhyay, eds. *Management of Capital Flows in India*. India: Oxford University Press.
- Stiglitz, J. E, and A. Weiss. 1981. Credit Rationing in a Market with Imperfect Information. *American Economic Review*. Vol. 71.
- Subbarao, D. 2013. Five Years of Leading the Reserve Bank – Looking Ahead by Looking Back. Tenth Nani A. Palkhivala Memorial Lecture, Mumbai, 29 August.
- StataCorp. 2013. *Stata 13 Base Reference Manual*. College Station, TX: Stata Press.
- Virmani, V. 2004. Operationalising Taylor-type Rules for the India Economy: Issues and Some Results (1992Q3–2001Q4).

## **Reserve Bank of India's Policy Dilemmas:**

### *Reconciling Policy Goals in Times of Turbulence*

This paper examines some of the more critical policy dilemmas facing the Reserve Bank of India (RBI) in its pursuit of stabilizing inflation and sustaining high growth.

## **About the Asian Development Bank**

ADB's vision is an Asia and Pacific region free of poverty. Its mission is to help its developing member countries reduce poverty and improve the quality of life of their people. Despite the region's many successes, it remains home to approximately two-thirds of the world's poor: 1.6 billion people who live on less than \$2 a day, with 733 million struggling on less than \$1.25 a day. ADB is committed to reducing poverty through inclusive economic growth, environmentally sustainable growth, and regional integration.

Based in Manila, ADB is owned by 67 members, including 48 from the region. Its main instruments for helping its developing member countries are policy dialogue, loans, equity investments, guarantees, grants, and technical assistance.



**ASIAN DEVELOPMENT BANK**

6 ADB Avenue, Mandaluyong City

1550 Metro Manila, Philippines

[www.adb.org](http://www.adb.org)